Chapter 8: Meningococcal Disease

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I. Disease Description

Meningococcal disease is a serious and potentially life-threatening infection caused by the bacterium *Neisseria meningitidis*. Common symptoms of meningococcal disease include high fever, neck stiffness, confusion, nausea, vomiting, lethargy, and/or petechial or purpuric rash. Without appropriate and urgent treatment, the infection can progress rapidly and result in death.

II. Background

Approximately 800–1,500 cases of meningococcal disease occur annually in the United States, a rate of 0.3–0.5/100,000 population.[1,2] *N. meningitidis* is one of the leading causes of bacterial meningitis in the United States. Dramatic declines in the incidence of *Streptococcus pneumoniae* and *Haemophilus influenzae* type b have been achieved as a result of using conjugate vaccines.[3,4]

N. meningitidis can be classified into 13 serogroups based on the immunologic reactivity of their capsular polysaccharides.5 Serogroups B, C, and Y each cause approximately one-third of meningococcal disease cases in the United States. The proportion of cases caused by each serogroup varies by age; serogroup B causes over 50% of cases in infants younger than 1 year of age, while serogroups C, Y, and W135 cause 75% of meningococcal disease in those 11 years and older.[6] There is currently no vaccine available for serogroup B.

Humans are the only natural reservoir for *N. meningitidis*. *N. meningitidis* organisms are gram-negative, aerobic diplococci that can attach to the surface of mucosal cells of the nasopharynx. There they multiply, bind to specific receptors, and are taken up by epithelial cells, which then transport the meningococci across the mucosal epithelium. In a small number of persons, the bacteria penetrate the mucosa and gain access to the bloodstream, resulting in systemic disease. Once colonized on the mucosal surfaces, meningococci can be transmitted from human to human through direct contact with large droplet respiratory secretions.

Carriage

Five to ten percent of adults are asymptomatic nasopharyngeal carriers of *N. meningitidis*. The frequency of carriage, like that of invasive disease, also varies by age. Adolescents and young adults have the highest rates of meningococcal carriage. Although asymptomatic carriage of both pathogenic and nonpathogenic strains is common, few carriers develop invasive disease. For the majority of people, carriage is an immunizing process that results in a systemic, serogroup-specific protective antibody response.[5]

Epidemiology

The epidemiology of meningococcal disease in the United States has changed dramatically over the past hundred years. Large outbreaks of meningococcal disease caused by serogroup A were common during the first half of the twentieth century, with primary attack rates as high as 310 per 100,000 population and case-fatality ratios of 70%.[7] Currently, serogroup A disease is exceedingly uncommon in the United States, while serogroup Y disease has emerged in importance. The proportion of meningococcal disease caused by serogroup Y increased from 2% during 1989–1991 to 37% during 1997–2002.[6]

Meningococcal disease occurs year-round but has a seasonal pattern with peak incidence occurring in later winter and early spring.[5] There is a natural cyclical pattern of meningococcal disease with peaks of disease occurring every 7–10 years (CDC, unpublished data). Current rates of meningococcal disease are at historic lows; the disease pattern of the past 10 years is outside the previously observed periodicity of disease.[1]

Risk factors

Risk factors for meningococcal disease include organism, host, and environmental factors. Persons with persistent complement component deficiencies (e.g., C5—C9, properidin, factor H, or factor D) or functional or anatomic asplenia are at increased risk for invasive meningococcal disease.[8]

Crowded living conditions can facilitate respiratory droplet transmission of meningococci. College freshman residing in dormitories are at greater risk of acquiring meningococcal disease than are college students not living in dormitories.[9] Active or passive smoking and recent upper respiratory tract infections also increase risk of disease.[7] Historically, blacks and persons of low socioeconomic status have been found to be at higher risk for meningococcal disease than whites and persons of high socioeconomic status, however in recent years these differences have diminished.[1,10] Race and socioeconomic status are likely markers for differences in risk factors such as household crowding, exposure to tobacco smoke, and urban residence.

Meningococcal disease rates in children younger than 1 year peak at 0-6 months.[1,11] More than 50% of meningococcal disease in children 0-6 months is caused by serogroup B; serogroup Y is also more prevalent in this age group.[1] In time, children gradually become exposed to meningococci and develop bactericidal antibodies. By the time they reach adulthood, 65%–85% of persons possess bactericidal antibody against meningococcal disease.[12]

Those who have close contact with case-patients, such as household members, are at a substantially increased risk for acquiring carriage and disease.[13] Rates of secondary disease are also elevated among daycare workers and attendees as well as among schoolchildren.[14,15]

Clinical

Diagnosing meningococcal disease is often challenging because its initial clinical manifestations are similar to more common but less serious illnesses. In addition, it can progress rapidly.

The common clinical manifestations of invasive meningococcal disease include meningitis, bacteremia, and pneumonia. Meningitis is observed in approximately 50% of invasive cases[1] and is characterized by abrupt onset of fever, headache, and stiff neck. Sometimes these clinical features are accompanied by nausea, vomiting, photophobia, and altered mental status. In infants, symptoms may have a slower onset, signs may be nonspecific, and neck stiffness may be absent. Approximately 40% of meningococcal disease cases present as bacteremia.[1] A portion of these cases will present as meningococcemia, the most severe manifestation of meningococcal bacteremia.[10] Signs of meningococcemia include sudden onset of fever and a characteristic petechial or purpuric rash, which may progress to purpura fulminans. The clinical course can include hypotension, acute adrenal hemorrhage, multiorgan failure, shock, and death. Patients with severe meningococcemia often respond poorly to treatment, and death can occur within hours of onset. Pneumonia occurs in approximately 10% of cases and occurs most frequently in older persons.[1,10] Diagnosing meningococcal pneumonia is difficult because isolation of the organism from sputum does not distinguish persons who are carriers from those with pneumonia caused by the organism.[16]

Much less common manifestations of meningococcal disease include myocarditis, endocarditis or pericarditis, arthritis, conjunctivitis, urethritis, pharyngitis, and cervicitis.

Of those who survive invasive disease, 10%–20% experience sequelae, including limb loss from gangrene, extensive skin scarring, or cerebral infarction. Persons with meningococcal meningitis who do not develop septic shock are less likely to die or experience these sequelae but are at risk of developing neurosensory hearing loss, mild to moderate cognitive defects, or seizure disorders.[17]

Treatment

The use of antibiotics has dramatically reduced mortality due to meningococcal disease. Before antibiotics were available, the case-fatality ratio for meningococcal disease was between 70% and 85%. Now with the widespread use of antibiotics, the case-fatality ratio for meningococcal disease is 10%–14%, although mortality may be as high as 40% among patients with meningococcemia.[5] Even with prompt treatment the case-fatality ratio for this condition remains high.

Because of the risks of severe morbidity and death, effective antibiotics should be administered promptly to patients suspected of having meningococcal disease. Multiple antimicrobial agents, including penicillins, are effective against *N. meningitidis*.[5] For patients who receive penicillin, eradication of nasopharyngeal carriage with rifampin, ciprofloxacin, or ceftriaxone is recommended prior to discharge from the hospital.

Chemoprophylaxis

Persons who have had close contact with patients who have meningococcal disease are at greatly increased risk for contracting the disease. The primary means of preventing the spread of meningococcal disease is antimicrobial chemoprophylaxis. Secondary cases are rare as a result of effective chemoprophylaxis for household members, contacts at daycare centers, and anyone else directly exposed to an infected patient's oral secretions (e.g., kissing, mouth-to-mouth resuscitation). Risk of secondary disease among close contacts is highest during the first few days after the onset of disease, which requires that chemoprophylaxis be administered as soon as possible. If given more than 14 days after the onset of disease, chemoprophylaxis is probably of limited or no benefit.[6] Oropharyngeal or nasopharyngeal cultures are not useful in determining the need for chemoprophylaxis and may unnecessarily delay the use of effective preventive measures (Table 1).

In areas of the United States where ciprofloxacin-resistant strains of *N. meningitidis* have been detected, ciprofloxacin should not be used for chemoprophylaxis. Use of azithromycin as a single oral dose has been shown to be effective for eradication of nasopharyngeal carriage and can be used on a limited basis where ciprofloxacin resistance has been detected.[18]

Table 1. Recommended chemoprophylaxis regimens for high-risk contacts and persons with invasive meningococcal disease

Drug	Age	Dose	Duration	Efficacy (%)	Cautions
Rifampin	<1 mo	5 mg/kg, orally, every 12 h	2 days		
	≥1 mo	10 mg/kg (maximum 600 mg), orally, every 12 h	2 days	90–95	Can interfere with efficacy of oral contraceptives and some seizure prevention and anticoagulant medications; may stain soft contact lenses. Not recommended for pregnant women.
Ceftriaxone	<15 y	125 mg, intramuscularly	Single dose	90–95	To decrease pain at injection site, dilute with 1% lidocaine.
	≥15 y	250 mg, intramuscularly	Single dose	90–95	
Ciprofloxacin	≥18 y	500 mg, orally	Single dose	90–95	Not recommended for persons <18 years of age. Not recommended for pregnant women.

Table 1. Recommended chemoprophylaxis regimens for high-risk contacts and persons with invasive meningococcal disease

Drug	Age	Dose	Duration	Efficacy (%)	Cautions
Azithromycin[a]		*10 mg/kg (maximum 500 mg)*	*Single dose*	*90*	Not recommended routinely. Equivalent to rifampin for eradication of *Neisseria meningitidis* from nasopharynx in one study.

Source: American Academy of Pediatrics. Meningococcal Infections. In: Pickering LK, Baker CJ, Long SS, McMillan JA, eds. Red Book: 2006 Report of the Committee on Infectious Diseases, 27th ed. Elk Grove Village, IL: American Academy of Pediatrics; 2006:456.

[a]Use only if fluoroquinolone-resistant strains of N meningitidis have not been identified in the community.[18]

III. Importance of Rapid Identification

Immediate recognition and treatment of meningococcal disease is critical. Persons with suspected cases should be treated promptly without waiting for laboratory confirmation. Reporting of cases is also crucial so that the proper control measures can be quickly implemented for prevention of secondary cases.

IV. Importance of Surveillance

Passive and active surveillance systems are used to monitor meningococcal disease, which is a reportable disease in the United States. Through a national passive reporting system, state health departments collect and transmit weekly reports of cases to CDC through the National Electronic Telecommunications System for Surveillance (NETSS).

The goals of meningococcal surveillance are

1. to detect outbreaks of meningococcal disease so that appropriate control measures can be promptly instituted, and
2. to assess changes in the epidemiology of meningococcal disease over time to permit the most efficient allocation of resources and formulation of the most effective disease control and prevention policies.[19]

Meningococcal serogroup surveillance data are important to monitor the impact of quadrivalent meningococcal conjugate vaccine (MCV4; Menactra®,sanofi pasteur; Menveo®, Novartis). Meningococcal serogroup data also help to determine the epidemiologic link between cases in cluster or outbreak situations.[19]

V. Disease Reduction Goals

The *Healthy People 2020* goal is to reduce incidence of meningococcal disease to 0.3 cases/100,000 population.[20] The first evidence of vaccine impact on rates of meningococcal disease in adolescents was observed in 2008-2009. Rates of serogroup C, Y, and W-135 meningococcal disease in adolescents declined by 50% from 2006-2007 to 2008-2009. These same decreases were not observed in infants less than one year of age or adults. These decreases were also not observed for serogorup B disease in adolescents.[21]

There is currently no vaccine in the United States to protect against serogroup B disease. Approximately one-third of meningococcal cases in the United States are caused by this serogroup; development of a vaccine against group B disease would further reduce the meningococcal disease rates.

VI. Case Definition

The following definitions can be used to describe a case of meningococcal disease:

Confirmed case: A confirmed case of meningococcal disease is defined by isolation of *N. meningitidis* from a normally sterile site (e.g., blood or cerebrospinal fluid [CSF]) from a person with clinically compatible illness.

Probable case: A probable case of meningococcal disease is defined by detection of *N. meningitidis* DNA by polymerase chain reaction or polysaccharide antigen in CSF (e.g., by latex agglutination or immunohistochemistry), or the presence of clinical purpura fulminans in the absence of diagnostic culture from a person with clinically compatible disease.

Primary case: A primary case of meningococcal disease is one that occurs in the absence of previous known close contact with another patient with meningococcal disease.

Secondary case: A secondary case of meningococcal disease is one that occurs among close contacts of a primary case-patient 24 hours or more after onset of illness in the primary patient.

Co-primary case: Co-primary cases are two or more cases that occur among a group of close contacts with onset of illness separated by less than 24 hours.

Close contacts: Close contacts of a patient who has meningococcal disease include

1. household members (including dormitory room, barracks),
2. child care center contacts, and
3. persons directly exposed to the patient's oral secretions (e.g., by kissing, mouth-to-mouth resuscitation, endotracheal intubation, or endotracheal tube management).[6]

VII. Laboratory Testing

N. meningitidis is a gram-negative, encapsulated, aerobic diplococcus. Thirteen different meningococcal serologic groups have been defined, five of which cause the great majority of disease (A, B, C, Y, and W135). The distinction between serogroups is based on the immunochemistry of the capsular polysaccharide, but more recently PCR of capsule biosynthesis genes has been used for determining the serogroup of isolates.[22] Serogroup A, C, Y and W135 polysaccharides all elicit a serogroup-specific immune response, which allows for a successful quadrivalent vaccine. The serogroup B capsular polysaccharide is poorly immunogenic, thus making it challenging to develop a vaccine to protect against this serogroup. Vaccine development efforts for serogroup B are focusing on outer membrane proteins (OMPs) or other surface molecules rather than the capsular polysaccharide.

Identification of N. meningitidis

The case definition for confirmed meningococcal disease requires isolation of *N. meningitidis* from a normally sterile site. Typically, the isolate comes from blood or CSF, but it can also be from joint, pleural, or pericardial fluid. Aspirates or skin biopsies of purpura or petechiae can yield meningococci in cases of meningococcemia. The typical medium used to grow the organism is chocolate agar or Mueller-Hinton medium in an atmosphere containing 5% carbon dioxide.[23] Gram staining is commonly used for identification of *N. meningitidis* and continues to be a reliable and rapid method for presumptive identification. If proper quality assurance/quality control is performed, intracellular gram-negative diplococci in CSF can be considered meningococci until proven otherwise.

In addition to bacteriology for definitive detection and identification, latex agglutination can be used for rapid detection of meningococcal capsular polysaccharides in CSF, although false-negative and false-positive results can occur. Antigen agglutination tests on serum or urine samples are unreliable for diagnosis of meningococcal disease.[5]

Real-time PCR detects DNA of meningococci in blood, CSF, or other clinical specimens. A major advantage of PCR is that it allows for detection of *N. meningitidis* from clinical samples in which the organism could not be detected by culture methods, such as when a patient has been treated with antibiotics before obtaining a clinical specimen for culture. Even when the

organisms are nonviable following antimicrobial treatment, PCR can still detect *N. meningitidis* DNA.[22] Because of the severity of meningococcal disease, it is critical to treat the patient as soon as infection is suspected, and not to delay to obtain culture or laboratory results first.

Susceptibility testing

Routine antimicrobial susceptibility testing of meningococcal isolates is not currently recommended. Surveillance of susceptibility patterns in populations should be conducted in order to monitor trends in *N. meningitidis* susceptibility. State and local health departments should notify the Centers for Disease Control and Prevention (CDC) if resistance to ciprofloxacin or other agents used for treatment or prophylaxis is detected.

Public health impact

Rapid and reliable results are crucial in determining the meningococcal serogroup in an outbreak because public health response will differ for vaccine-preventable or non-vaccine-preventable disease. Outbreaks of meningococcal disease are usually caused by the same or closely related strains.[6] Molecular genotyping techniques such as pulsed-field gel electrophoresis, 16S rRNA gene sequencing, or multilocus sequence typing are used for subtype characterization of an outbreak clone.[24,25] This subtyping helps to better define the extent of the outbreak but is not necessary for determining response during the outbreak.

VIII. Reporting

Cases of meningococcal disease should be promptly reported to the appropriate local or state health department. Case information should be reported to CDC through the National Notifiable Diseases Surveillance System (NNDSS), through the National Electronic Telecommunications System for Surveillance (NETSS), or the National Electronic Disease Surveillance System (NEDSS) within 14 days of the initial report to the state or local health department (see Appendix 9).

IX. Vaccination

Two quadrivalent meningococcal conjugate vaccines, MCV4 (Menactra®, Sanofi Pasteur; Menveo®, Novartis) are licensed for use in the United States. Both vaccines are licensed for persons aged 2–55 years. MCV4 is the preferred vaccine for people aged 2–55 years; meningococcal polysaccharide vaccine should be used for people >55 years. Approximately 7–10 days are required after vaccination for development of protective antibody levels.

The Advisory Committee on Immunization Practices (ACIP) recommends routine vaccination of persons with MCV4 at age 11 or 12 years, with a booster dose at age 16 years. For adolescents who receive the first dose at age 13 through 15 years, a one-time booster dose should be administered preferably at age 16 through 18 years. Persons who receive their first dose of MCV4 at or after age 16 years do not need a booster dose, unless they remain at increased risk for meningococcal disease. Routine vaccination of healthy persons who are not at increased risk for exposure to *N. meningitidis* is not recommended after age 21 years.[26]

Vaccination is also recommended for certain persons who have an increased risk for meningococcal disease, including 1) college freshman living in dormitories, 2) microbiologists who are routinely exposed to isolates of *N. meningitidis*, 3) military recruits, 4) persons who travel to or reside in countries in which meningococcal disease is hyperendemic or epidemic, particularly if contact with the local population will be prolonged, 5) persons who have persistent complement component deficiencies (e.g., C5-C9, properidin, factor H, or factor D), and 6) persons who have anatomic or functional asplenia.[5]

Persons previously vaccinated with either MCV4 or MPSV4 who are at prolonged increased risk for meningococcal disease should be revaccinated with MCV4. Persons at prolonged increased risk include 1) persons who have persistent complement component deficiencies, 2) persons with anatomic or functional asplenia, and 3) persons who have prolonged exposure (e.g., microbiologists routinely working with *N. meningitidis*, or travelers to or residents of countries where meningococcal disease is hyperendemic or epidemic).[27]

Data indicate that the immune response to a single dose of MCV4 is not sufficient in persons with certain medical conditions. Persons with persistent complement component deficiencies or asplenia should receive a 2-dose primary series administered 2 months apart and then receive a booster dose every 5 years. Adolescents aged 11 through 18 years with HIV infection should be routinely vaccinated with a 2-dose primary series. Other persons with HIV who are vaccinated should receive a 2-dose primary series administered 2 months apart. All other other persons at increased risk for meningococcal disease (e.g. microbiologists or travelers to an epidemic or highly endemic country) should receive a single dose. Persons previously vaccinated with a single dose at age ≥7 years and who are at prolonged increased risk should be revaccinated 5 years after their previous meningococcal vaccine, and persons who previously were vaccinated with a single dose at ages 2-6 years and are at prolonged increased risk should be revaccinated 3 years after their previous meningococcal vaccine.[26]

Summary of meningococcal conjugate vaccine recommendations, by risk group—Advisory Committee on Immunization Practices (ACIP), 2010

Risk group	Primary series	Booster dose
Persons aged 11 through 18 years	1 dose, preferably at age 11 or 12 years	At age 16 years if primary dose at age 11 or 12 years
		At age 16 through 18 years if primary dose at age 13 through 15 years
		No booster needed if primary dose on or after age 16 years
HIV-infected persons in this age group	2 doses, 2 months apart	At age 16 years if primary dose at age 11 or 12 years
		At age 16 through 18 years if primary dose at age 13 through 15 years
		No booster needed if primary dose on or after age 16 years
Persons aged 2 through 55 years with persistent complement component deficiency* or functional or anatomical asplenia	2 doses, 2 months apart	Every 5 years
		At the earliest opportunity if a 1-dose primary series administered, then every 5 years
Persons aged 2 through 55 years with prolonged increased risk for exposure†	*1 dose*	*Persons aged 2 through 6 years: after 3 years*
		Persons aged 7 years or older: after 5 years§

Abbreviation: HIV = human immunodeficiency virus.

* *Such as C5--C9, properidin, or factor D.*

† *Microbiologists routinely working with Neisseria meningitidis and travelers to or residents of countries where meningococcal disease is hyperendemic or epidemic.*

§ *If the person remains at increased risk.*

Polysaccharide vaccine

The quadrivalent meningococcal polysaccharide vaccine, MPSV4 (Menomune-A/C/Y/W135®, sanofi pasteur) has been available since the 1970s. Meningococcal polysaccharide vaccines have been used extensively in mass vaccination programs, among international travelers, and in the military.[6] Usefulness of the polysaccharide vaccine is limited because it does not confer long-lasting immunity and does not cause a sustainable reduction of nasopharyngeal carriage of *N. meningitidis*, and therefore does not interrupt transmission sufficiently to elicit herd immunity.[6]

Conjugate vaccine

The characteristics of conjugate vaccines offer a number of improvements over polysaccharide vaccines. Examples of the successful implementation of conjugate vaccines can be seen in the reduction of *Haemophilus influenzae* serotype b disease in children younger than 5 years old in

the United States[4] and in the dramatic reduction in invasive disease caused by *Streptococcus pneumoniae*.[3]

Conjugating polysaccharide to a protein carrier that contains T-cell epitopes creates a T-cell–dependent immune response. This results in a strong anamnestic response at re-exposure, a substantial primary response in infants, and possibly in reduction in the frequency of *N. meningitidis* carriage, protecting unvaccinated persons through herd immunity.[6]

MCV4 was demonstrated to be non-inferior to MPSV4 and was licensed based on safety and immunogenicity data. Studies to evaluate the effectiveness of the vaccine, including its effect on carriage, are currently under way.

X. Enhancing Surveillance

CDC coordinates active, population- and laboratory-based surveillance for invasive meningococcal disease as part of the Active Bacterial Core surveillance (ABCs) system, through the Emerging Infections Program (EIP). ABCs comprises 10 sites which collect data from all patients from whom *N. meningitidis* was isolated from a normally sterile body site. This surveillance program allows for detection of patterns in causative meningococcal serogroups and accurate estimation of age-specific incidence rates.[6] ABCs data have been used to track meningococcal disease trends, including the emergence of serogroup Y meningococcal disease. ABCs website is at http://www.cdc.gov/abcs/index.html.

In addition, many states have their own enhanced surveillance system for meningococcal disease.

XI. Case Investigation

All reports of suspected meningococcal disease should be investigated immediately. CDC is available to assist with epidemiologic and laboratory investigations during outbreaks. A critical component of case investigation is ensuring that all close contacts (see definitions) receive appropriate chemoprophylaxis to eradicate nasopharyngeal carriage of meningococci and prevent secondary disease. Approximately 70% of secondary cases occur within 7 days of disease onset in the index patient. Antibiotic administration within 24 hours of identifying a case is ideal; after 14 days it is unlikely that antibiotic chemoprophylaxis is helpful.[6] Rifampin, ciprofloxacin, ceftriaxone, and azithromycin are all effective as chemoprophylaxis against meningococcal disease.[6,18 (Table 1)]

XII. Outbreaks

More than 98% of meningococcal disease cases in the United States are sporadic, while the other 2% are associated with outbreaks.[28] Historically, the majority of outbreaks have been caused by serogroup C, although in recent years serogroup Y and serogroup B outbreaks have been reported (CDC, unpublished data).

Attack rates

Attack rates are calculated to determine the risk for disease among the general population and to determine whether overall rates have increased. Related cases, defined as secondary and co-primary, should not be included in the calculation of the attack rate. To calculate a primary attack rate all confirmed cases of the same serogroup should be summed, secondary cases should be excluded, and each set of co-primary cases should be counted as one case.

To calculate an attack rate:

$$\text{attack rate/100,000} = \frac{\text{number of primary confirmed or probable cases occurring during a 3-month period}}{\text{number of population at risk during the same time period}} \times 100{,}000$$

Community and organization outbreaks

A community-based outbreak is defined as the occurrence of three or more confirmed or probable primary cases of meningococcal disease in a period of 3 months or less among persons residing in the same area who are not close contacts and who do not share a common affiliation, with a primary attack rate of 10 or more cases per 100,000 population.[6] Examples of a community-based outbreak include a neighborhood, town, or county.

An organization-based outbreak is defined as the occurrence of three or more confirmed or probable cases of meningococcal disease of the same serogroup in period of 3 months or less among persons who have a common affiliation but no close contact with each other, resulting in a primary disease attack rate of 10 or more cases per 100,000 persons.[6] In some instances the attack rate will be greater than 10 cases per 100,000 population with only two or three cases.[6] In these situations, vaccination may be considered after only two primary cases are identified. Examples of an organization-based outbreak include cases in schools, churches, and universities.

Population at risk

A population at risk comprises persons who are considered to be at increased risk for meningococcal disease compared with historical rates of disease in the same group of the general U.S. population. Population at risk is usually defined on the basis of community of residence or organizational affiliation. The population at risk is used as the denominator in calculations of the disease attack rate. In organization-based outbreaks the population at risk can be defined as the group of persons that best represent the affiliation. In community-based outbreaks, patients do not share any common affiliation besides an area of residence.[6]

Decision to vaccinate

When deciding to implement a mass vaccination campaign to prevent meningococcal disease, one must consider whether the cases represent an outbreak or an unusual clustering of endemic cases. Mass vaccination programs are expensive, require considerable public health effort, and may create excessive concern among the public. Because the number of cases in outbreaks is usually not substantial, this determination requires evaluation and analysis of the patterns of disease occurrence.[15]

Vaccination of the population at risk should be considered if the attack rate is greater than 10 cases per 100,000 population, but the actual attack rate at which the decision to vaccinate is made will vary. The following factors should be considered when making the decision to vaccinate:

- Completeness of case reporting and number of possible cases of meningococcal disease for which bacteriologic confirmation or serogroup data are not available
- Occurrence of additional cases of meningococcal disease after recognition of a suspected outbreak (e.g., if the outbreak occurred 2 months previously and no additional case have occurred, vaccination might be unlikely to prevent additional cases of meningococcal disease)
- Logistic and financial considerations

Current meningococcal vaccines are not effective against *N. meningitidis* serogroup B; therefore, vaccination should not be considered during a serogroup B outbreak.

Other control measures

Mass chemoprophylaxis is not recommended for control of large outbreaks of disease for multiple reasons: cost of drug and administration, difficulty of ensuring simultaneous administration of drugs to substantial populations, drug side effects, and emergence of resistant organisms. In most outbreak settings, these disadvantages outweigh the potential benefit. Situations in which mass chemoprophylaxis could be successful include those involving limited or closed populations, such as a single school or residential facility. This is especially important in serogroup B outbreaks, since vaccines cannot be used for control and prevention. If the decision is made to use mass chemoprophylaxis, it should be administered to all persons at the same time.[6]

It is possible that even in a vaccine-preventable, organization-based outbreak, antibiotic distribution may be a more timely intervention, since preventive antibodies take 7–10 days to develop after vaccination.[6] Again, the potential benefit of mass chemoprophylaxis must be weighed against the possible emergence of antibiotic resistance and the logistics of launching a prophylaxis campaign.

Restricting travel to areas with an outbreak, closing schools or universities, or cancelling sporting or social events are not recommended measures for outbreak control in the United States. A crucial part of managing suspected meningococcal disease outbreaks and promoting early case recognition is educating communities, physicians and other healthcare workers about meningococcal disease.[6]

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